providers by claiming that these are local calls. The Commission should affirm its previous findings that such compensation should only apply to local calls. Since the calls in question are interstate, jointly provided meet point billing rules should apply.

V. CONCLUSION

Low cost, readily available Internet access is a goal of USTA's members as well as the Commission. Meeting the needs of residential customers, IXCs, and other business customers, as well as information service providers, is another goal -- and legal obligation -- of USTA's members. To achieve these goals, new pricing policies must be adopted to provide the proper incentives for efficient investment, both in information services and the LECs' networks.

Respectfully submitted,

UNITED STATES TELEPHONE ASSOCIATION

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March 24, 1997

BEFORE THE
FEDERAL COMMUNICATIONS COMMISSION

In the Matter of	)	
	)	
Usage of the Public Switched	)	CC Docket No. 96-263
Network by Information Service	)	
and Internet Access Providers	)	

AFFIDAVIT OF
J. GREGORY SIDAK AND DANIEL F. SPULBER

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INTRODUCTION

J. Gregory Sidak and Daniel F. Spulber, being duly sworn, depose and say:

1. My name is J. Gregory Sidak. I am the F. K. Weyerhaeuser Fellow in Law and Economics at the American Enterprise Institute for Public Policy Research (AEI), where I direct AEI's Studies in Telecommunications Deregulation. I am also a senior lecturer at the Yale School of Management, where I teach a course on telecommunications regulation with Professor Paul W. MacAvoy. I served as Deputy General Counsel of the Federal Communications Commission from 1987 to 1989, and as Senior Counsel and Economist to the Council of Economic Advisers in the Executive Office of the President from 1986 to 1987.

2. My academic research concerns telecommunications regulation, antitrust policy, and constitutional law issues concerning economic regulation. I have written four books concerning pricing, costing, competition, and investment in regulated network industries: *Deregulatory Takings and the Regulatory Contract: The Competitive Transformation of Network Industries in the United States* (Cambridge University Press, forthcoming 1997), co-authored with Daniel F. Spulber; *Toward Competition in Local Telephony* (MIT Press & AEI Press 1994), co-authored with William J. Baumol; *Transmission Pricing and Stranded Costs in the Electric Power Industry* (AEI Press 1995), also co-authored with William J. Baumol; and *Protecting Competition from the Postal Monopoly* (AEI Press 1996), also co-authored with Professor Spulber. I am also the author of a fifth book, *Foreign Investment in American Telecommunications* (University of Chicago Press 1997), and of more than twenty-five scholarly articles in the *Journal of Political Economy*, *California Law Review*, *Columbia Law Review*,

Cornell Law Review, Duke Law Journal, Georgetown Law Journal, Harvard Journal on Law & Public Policy, New York University Law Review, Northwestern University Law Review, Southern California Law Review, Yale Journal on Regulation, and elsewhere. A 1996 survey ranked me among the fifty most prolific authors of articles published in the twenty most frequently cited law reviews. I have testified before the U.S. Senate and House of Representatives, and my writings have been cited by the Supreme Court, by the lower federal courts, by state and federal regulatory commissions, and by the Judicial Committee of the Privy Council of the House of Lords. I have been a consultant on regulatory and antitrust matters to the Antitrust Division of the U.S. Department of Justice, to the Canadian Competition Bureau, and to more than thirty companies in the telecommunications, electric power, natural gas, mail delivery, and computer software industries in North America, Europe, Asia, and Australia.

3. I received A.B. and A.M. degrees in economics and a J.D. from Stanford University, where I was a member of the *Stanford Law Review*, and I served as a law clerk to Chief Judge Richard A. Posner during his first term on the U.S. Court of Appeals for the Seventh Circuit.

4. My name is Daniel F. Spulber. I am the Thomas G. Ayers Professor of Energy Resource Management and Professor of Management Strategy at the J. L. Kellogg Graduate School of Management, Northwestern University. I was previously Professor of Economics and Professor of Economics and Law at the University of Southern California. I have has also taught economics at Brown University and the California Institute of Technology. I have conducted extensive research over the last nineteen years in the areas of regulation, management strategy, industrial organization, microeconomic theory, and energy economics.

5. I am the author of the textbook *Regulation and Markets* (MIT Press 1989). I have written two other books on the regulation of network industries, *Deregulatory Takings and the Regulatory Contract: The Competitive Transformation of Network Industries in the United States* (Cambridge University Press, forthcoming 1997) and *Protecting Competition from the Postal Monopoly* (AEI Press,

1996), both co-authored with J. Gregory Sidak. I have published more than fifty articles on regulation, pricing, management strategy, and related topics in numerous academic journals, including the *American Economic Review*, the *Columbia Law Review*, the *Journal of Economic Perspectives*, the *Journal of Economic Theory*, the *Journal of Law and Economics*, the *New York University Law Review*, the *Quarterly Journal of Economics*, the *RAND Journal of Economics*, and the *Yale Journal on Regulation*. I am the founding editor of the *Journal of Economics & Management Strategy*, published by the MIT Press. A 1996 survey published in *Economic Inquiry* ranked me sixth among the most prolific authors publishing in the leading academic journals of economics.

6. I hold a B.A. degree in economics from the University of Michigan, and an M.A. and a Ph.D. in economics from Northwestern University.

7. We have been asked by the United States Telephone Association to evaluate the economic implications of allowing Internet service providers (ISPs) to avoid paying for interstate access by taking advantage of the FCC's access-charge exemption for enhanced service providers (ESPs). We present this affidavit in our individual capacities, and not on behalf of the American Enterprise Institute, the Kellogg Graduate School of Management, or the Yale School of Management.

EXECUTIVE SUMMARY

8. We agree with the Commission's conclusion that the dramatic growth of Internet usage and Internet services "create significant benefits for the economy and the American people,"[1] and we acknowledge that, through its enactment of the Telecommunications Act of 1996, Congress made it a priority of public policy "to preserve the vibrant and competitive free market that presently exists for the Internet and other interactive computer services, unfettered by Federal or State regulation."[2] The question posed by the *Notice of Inquiry* is whether, in light of the Commission's current policy of exempting ESPs

1. *Notice* ¶ 282.
2. 47 U.S.C. § 230(b)(2).

from paying interstate access charges, the "vibrant and competitive free market" will be preserved as the growth of Internet usage strains the capacity of the public switched telecommunications network (PSTN).

9. Our principal economic conclusions are as follows:

- Voice transmission and data transmission represent distinct types of demands requiring distinct pricing methods to alleviate adverse selection problems and to address the costs of serving those demands.
- Continuation of the ESP exemption would promote free riding on the PSTN by ISPs and their customers.
- Continuation of the ESP exemption creates pricing distortions that result in inefficient consumption decisions, inefficient investment incentives, and congestion externalities.
- The Commission should exercise forbearance by decontrolling access prices and allowing the competitive market for access services to determine access pricing on the PSTN.
- The Commission should refrain from picking technology winners and allow markets to determine the best access technologies.

In our view, the Commission's *Notice of Inquiry* fails to address adequately the economic consequences that flow naturally from the agency's existing policy on the pricing of access for ESPs.

10. Until recently, research on congestion and Internet usage addressed congestion *of the Internet*—congestion of the routers and fiber-optic backbones that constitute the Internet. The issue has since become congestion of the loops, switches, and trunks of the PSTN that are used when consumers gain access to the Internet through their local exchange carriers. It is evidence of the speed at which Internet usage has congested the PSTN that in the summer of 1994, when Professors Jeffrey MacKie-Mason and Hal Varian discussed congestion and the pricing of the Internet in one of the few articles on the subject published in any economics journal, they mentioned neither congestion of the PSTN nor the company that has since become synonymous with household access to the Internet, America Online.[3] The same is true of the large number of papers on Internet pricing and congestion that have been posted on

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3. *See* Jeffrey K. MacKie-Mason & Hal Varian, *Economic FAQs About the Internet*, 8 J. ECON. PERSPECTIVES 75 (1994).

web sites.[4] As we shall demonstrate, the recent shift from concern over congestion of the Internet to concern over congestion of the PSTN underscores a number of questions of law and economics that have great relevance to the Commission's formulation of sound public policy. In turn, those questions arise from the fundamental differences between the circuit-switched technology of voice telephony over the PSTN and the packet-switched technology employed to transmit data over the Internet.

11. The problem of congestion of the PSTN due to Internet usage has an obvious solution: The pricing of access to the Internet over the PSTN must depend on both capacity and usage. As stated in the *Notice*, since 1983 it has been the Commission's policy "that, although enhanced service providers (ESPs) may use incumbent LEC facilities to originate and terminate interstate calls, ESPs should not be required to pay interstate access charges."[5] Moreover, the Commission evidently believes that the subsidy from incumbent LECs to ESPs that is inherent in the ESP exemption is responsible for the growth of the Internet.[6] Even if the Commission is correct in its assumption about the consequences of its access subsidy for the growth of ISPs, it does not follow that a continuation of that subsidy is necessary today

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4. Many of the posted papers were presented at the MIT Workshop on Internet Economics in March 1995 and are forthcoming in INTERNET ECONOMICS (Lee McKnight & Joseph P. Bailey eds., MIT Press 1997). *See* Lee W. McKnight & Joseph P. Bailey, *An Introduction to Internet Economics* <http://www.press.umich.edu:/jep/works/McKniIntro.html>; Padmanabhan Srinagesh, *Internet Cost Structures and Interconnection Agreements* <http://www.press.umich.edu:/jep/works/SrinCostSt.html>; Mitrabarun Sarkar, *An Assessment of Pricing Mechanisms for the Internet—A Regulatory Imperative* <http://www.press.umich.edu:/jep/works/SarkAssess.html>; Ketil Danielsen & Martin Weiss, *User Control and IP Allocation* <http://www.press.umich.edu:/jep-/works/DanieContr.html>; Jeffrey K. MacKie-Mason, Liam Murphy & John Murphy, *The Role of Responsive Pricing in the Internet* <http://www.press.umich.edu:/jep/works/MacKieResp.html>; Martyne M. Hallgren & Alan K. McAdams, *A Model for Efficient Aggregation of Resources for Economic Public Goods on the Internet* <http://www.press.umich.edu:/jep/works/-HallgModel.html>; Qiong Wang, Jon M. Peha & Marvin A. Sirbu, *The Design of an Optimal Pricing Scheme for ATM Integrated-Services Networks* <http://www.press.umich.edu:/jep/works/WangOptPr.html>; Joseph P. Bailey, *Economics and Internet Interconnection Agreements* <http://www.press.umich.edu:/jep/works/BailEconAg.html>; Frank P. Kelly, *Charging and Accounting for Bursty Connections* <http://www.press.umich.edu:/jep/works/KellyCharg.html>; David W. Crawford, *Pricing Network Usage: A Market for Bandwidth or Market for Communications?* <http://www.press.umich.edu:/jep/-works/CrawMarket.html>; Jiong Gong & Padmanabhan Srinagesh, *The Economics of Layered Networks* <http://-www.press.umich.edu:/jep/works/GongEconLa.html>; Loretta Anania & Richard Jay Solomon, *Flat: The Minimalist B-ISDN Rate* <http://www.press.umich.edu:/jep/works/AnaniaFlat.html>; Nevil Brownlee, *New Zealand Experiences with Network Traffic Charging* <http://www.press.umich.edu:/jep/works/BrownNewZe.html>; David D. Clark, *A Model for Cost Allocation and Pricing in the Internet* <http://www.press.umich.edu:/jep/works/ClarkModel.html>; Alok Gupta, Dale O. Stahl & Andrew B. Whinston, *A Priority Pricing Approach to Manage Multi-Service Class Networks in Real-Time* <http://www.press.umich.edu:/-jep/works/GuptaPrior.html>.

5. *Notice* ¶ 284 (citing MTS and WATS Market Structure, Memorandum Opinion and Order, Dkt. No. 78-72, 97 F.C.C.2d 682, 711–22 (1983) (*Access Charge Reconsideration Order*); Amendments of Part 69 of the Commission's Rules Relating to Enhanced Service Providers, Order, CC Dkt. No. 87-215, 3 F.C.C. Rcd. 2631 (1988) (*ESP Exemption Order*)).

6. *Notice* ¶ 285.

and reconcilable with Congress's intent in the Telecommunications Act of 1996 to make subsidies explicit and competitively neutral in their funding.

12. The proposition that access to the Internet over the PSTN should be priced on the basis of economic costs is not necessarily at odds with the proposition that the development of the Internet deserves to be subsidized. In particular, if the government wishes to subsidize the development of the Internet, it should do so by a more efficient means than the FCC's current policy of exempting an Internet service provider from paying access charges to the local exchange carriers whose networks are used to connect customers to the ISP. Such a policy of embedding a subsidy in the pricing of network usage—or, more correctly, *failing* to place any price on an important and growing form of usage of the PSTN—can only have deleterious effects for the long-term quality of the PSTN. As Congress well knows, there is no free lunch in a "vibrant and competitive free market." If the Commission were to continue to allow ISPs to avoid access charges under the exemption for enhanced service providers, the natural and unavoidable implication would be a reduction in LEC investment and a deterioration of the PSTN. That network deterioration, in turn, would cramp the "vibrant and competitive free market" for Internet services that Congress seeks to promote. In short, the substantial benefits that can be derived from the Internet should not cause policy makers to ignore the significant costs that this powerful communications technology imposes on the operators and users of the nation's voice telephony network.

13. The larger question posed by the *Notice of Inquiry*, which we examine in part I, concerns the role that competitive prices play in influencing supply and demand in the market for access to Internet services over the PSTN. The *Notice of Inquiry* emphasizes measures that the Commission might undertake to expand the supply of network capacity yet ignores the role that prices play in rationing demand for such capacity. In contrast, we present an economic analysis of the demand for and supply of transmission services. We show that the demand to transmit voice and the demand to transmit data are distinct, and that the current pricing regime for access to the Internet over the PSTN is socially costly because it

encourages adverse selection.

14. In part II we examine the economics of network congestion. We show that the discussion of Internet congestion typically obscures the fact that different portions of both the PSTN and the ISP's own network are subject to congestion caused by untimed usage of the Internet. Congestion at any one node in that network can cause externalities for the PSTN. Thus, even the internal pricing decisions of an ISP can directly affect the congestion of the PSTN. The ESP exemption creates congestion externalities that can only worsen and thus threaten the integrity of the PSTN.

15. In part III we examine the pricing of access to ISPs over the PSTN. We show that the FCC should end the current subsidy to ISPs because it induces free riding on the PSTN. LECs should have flexibility in setting market-based access charges. The market for access, not a government regulator, should choose the best technologies for data transmission.

16. In part IV we explain that the revenues from second lines, and from ISP rental of lines are unlikely to compensate the incumbent LEC for the costs of congestion of the PSTN due to Internet usage.

17. In part V, we argue that the ESP exemption is incompatible with the policy direction in the Telecommunications Act of 1996 to make subsidies, if they are to be permitted at all, explicit and competitively neutral.

I. Economic Analysis of the Demand for and Supply of Transmission Services

18. In this part, we present an economic analysis of the demand for and supply of transmission services. We show that there are two basic types of consumer demand for transmission services—voice and data. There are also two basic types of supply of transmission services, one suited for voice and another for data. The public switched telephone network as currently designed is suited for voice transmission and is poorly equipped to handle both voice and data efficiently. The flat-rate pricing

of local service and the zero access charge for enhanced service providers together create incentives for inefficient usage on the part of consumers and discourage investment on the part of suppliers. Those price distortions created by state and federal regulations create inefficient outcomes in the market for transmission services. If left in place, those pricing policies would severely damage the quality of the PSTN while retarding the growth of information services.

A. The Demand for and Supply of Transmission

1. The Market Demand for Transmission

19. *Demand* is defined by economists as a schedule of prices and quantities that describes the total amount of a good or service demanded at each price level. As prices fall, the quantity demanded of a service increases. The *market demand* for a good or service is the sum of individual consumer demands for that good or service. Changes in the quantity demanded in response to price changes reflect the underlying possibilities for purchasing substitute goods and services that are available for consumers. Thus, market demand is a highly useful tool for representing consumer choices at alternative prices.

20. Market demand for transmission services can be divided into two categories: demand for voice transmission ("voice demand"), and demand for data transmission ("data demand"). Voice demand refers to traditional demand for voice telephony. Data demand refers to access to the Internet, including access to Internet providers, connection to proprietary services (America Online, Compuserve, and others), file transfers, usage of electronic bulletin boards, and so forth. In addition, data demand includes the use of an employer's computers by those working at home, telecommuting, home banking, and on-line services calls. Those types of calls have characteristics similar to Internet access.[7] Data demand for access includes the sending and receiving of digitized information, such as documents, e-mail, Internet telephony, and video transmission.

21. The total demand for transmission access services is the summation of voice demand and

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7. Amir Atai & James Gordon, *Impacts of Internet Traffic on LEC Networks and Switching Systems* (Bellcore 1996).

data demand. Therefore, consideration of demand for access to the public switched telephone network must include both types of demand. Those two types of demand have fundamentally different characteristics. According to Drs. Amir Atai and James Gordon of Bellcore, the Internet-related traffic's "qualitatively new characteristics are challenging the engineering, forecasting, planning and operational procedures established by the former Bell System over the past 80 years."[8] Clearly, the different characteristics require different technologies to provide services. Moreover, we will demonstrate that they require fundamentally different pricing methods.

2. Technology and the Supply of Transmission

22. Transmission technology also can be divided into two broad categories: circuit-switched networks and packet-switched networks. Generally speaking, circuit-switched networks are designed to provide voice transmission and are best suited for that purpose. Packet-switched networks are designed to provide data transmission and are best suited for that purpose, although technological change introduces some important subtleties.

23. This distinction between circuit switching and packet switching suggests the need to separate voice traffic from data traffic, and the need to upgrade networks to handle the two types of services in an integrated manner. Transmitting data on circuit-switched networks represents an inefficient use of that network. Such inefficient usage is encouraged by the states' current regulated pricing of local service and the FCC's current regulatory controls on interstate access charges.

24. A *circuit-switched* network establishes a fixed-capacity end-to-end connection that remains in place for the duration of the call.[9] The traditional plain old telephone service (POTS) employs a circuit-switched network that is designed for analog transmission of voice telecommunications. The callers control the line until the call is completed.

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8. *Id.* at 1.
9. WILLIAM STALLINGS, NETWORKING STANDARDS: A GUIDE TO OSI, ISDN, LAN, AND MAN STANDARDS 277 (Addison Wesley 1993); DANIEL MINOLI, TELECOMMUNICATIONS TECHNOLOGY HANDBOOK 54 (Artech House 1991).

25. A circuit-switched network also can handle data transmissions. The data transmission travels on the end-to-end circuit, which is not shared with other data transmissions while the call is in progress. The drawback of using a circuit-switched network for data transmission is that the data communication ties up more scarce transmission capacity than is needed to send the data. Moreover, in a circuit-switched network the originating and terminating devices must transmit and receive at the same data rate, which limits interconnection of computers and terminals.[10] Thus, a circuit-switched network is an inefficient means for transmitting data.[11]

26. In contrast, a *packet-switched* network breaks down the data stream being transmitted into "packets" comprised of a number of bytes that are independently routed to their destination, where the message being transmitted is reassembled.[12] Packet-switched networks are designed to handle data transmission, using network systems efficiently by allowing multiple data communications to share the same line and by sending data packets from the same transmission along possibly different routes to the destination to take advantage of available network capacity.[13] As Bellcore has noted, packet-switching technology

> is particularly well-suited for applications characterized by short *bursty* transmissions. Such applications take full advantage of packet switching's ability to share transmission facilities efficiently among multiple conversations, even when the throughput demands of each conversation vary widely over time. Typical applications with short, bursty traffic characteristics are database queries, credit authorization transactions, certain health care transactions, Automated Teller Machine (ATM) transactions, and reservation/shopping transactions.[14]

It is telling that Bellcore's assessment of the application of packet-switching, published in 1994, did not even mention the Internet by name.

27. A packet-switched network is not necessarily the best means of transmitting voice, without

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10. STALLINGS, *supra* note 9, at 277.

11. *Id.*

12. MINOLI, *supra* note 9, at 55-56.

13. *See, e.g.*, JOSEPH A. PECAR, ROGER J. O'CONNOR & DAVID A. GARBIN, THE MCGRAW-HILL TELECOMMUNICATIONS FACTBOOK 210-13 (McGraw-Hill, Inc. 1993).

14. BELL COMMUNICATIONS RESEARCH, BOC NOTES ON THE LEC NETWORKS—1994, at 14-100 (Bellcore 1994) (emphasis in original).

additional enhancements. Dr. Vinton G. Cerf, Senior Vice President for Internet Architecture of MCI Communications Corp. and founder of the Internet, has observed that "the Internet isn't free," and although the Internet is well suited for e-mail and non-real-time services,

> it will cost more to service interactive voice calls than it does to handle other forms of Internet traffic. Depending on the volume of various demand, Internet could well end up having to differentiate among the various services and charge more for those that use up more capacity. Current analyses suggest that the cost of handling domestic voice traffic is actually about the same, whether it is handled by conventional circuit switching or by Internet packet switching.[15]

Thus, Cerf recommends the separation of voice and data traffic on the Internet. He has also observed that the "attraction of Internet voice is partly a consequence of the difference between access charges levied by local exchange carriers for voice calls versus the no-access charge for data calls."[16]

28. In broadband integrated services digital networks (ISDN), circuit switching and packet switching are endpoints of a continuum of alternative techniques, ranging from circuit switching at one end, to multirate circuit switching, to cell relay (asynchronous transfer mode), to frame relay, and finally to packet switching at the other end.[17] Cell relay uses packets of fixed length called "cells" while frame relay uses packets of variable length called "frames."[18] Cell relay or asynchronous transfer mode (ATM) allows the creation of virtual channels and "is the culmination of all the developments in circuit and packet switching over the past twenty years."[19] In a switched broadband network with fiber-optic access (fiber-to-the-curb), voice and data can be sent over the same network with voice and data switching, and efficient connections to Internet service providers, interexchange carriers, and other networks. Until the development and installation of such networks, it is inefficient to combine voice and data transmission on the same circuit-switched network.

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15. Vinton G. Cerf, *The Internet Isn't Free*, On Technology, MCI Communications Corp. (1997) <http:\\www.mci.com\-technology\cerfreport0996.shtml>.

16. *Id.*

17. STALLINGS, *supra* note 9, at 275 (citing MARTIN DE PRYCKER, ASYNCHRONOUS TRANSFER MODE: SOLUTION FOR BROADBAND ISDN (Ellis Horwood 1991)).

18. *Id.* at 278.

19. *Id.* at 277.

29. There are many different technologies available for the supply of transmission access, and many different solutions to the problem of congestion.[20] These options include:

- Continued reliance on the existing circuit-switched PSTN (the status quo)
- Modification of the PSTN to handle data traffic by reducing congestion in the trunking network and terminating switches (dialed number triggers used to reroute data traffic, or modem pools maintained by LECs with data transported to ISPs over a data network)
- Modification of the PSTN using preswitch equipment to reroute calls to the ISPs onto a data network bypassing the LECs switch
- Modification of the PSTN using integrated services digital network (ISDN) lines between the subscriber and the switch
- Modification of the PSTN using asymmetrical digital subscriber lines (ADSL) between the subscriber and the switch
- Bypass of the PSTN for data transmission using cable modems and cable television system transmission for access to ISPs
- Bypass of the PSTN for data transmission using wireless access to ISPs

Which of those technological solutions is best? The answer is not one for the Commission to supply. As Gregory Rosston and Jeffrey Steinberg of the FCC similarly noted in their January 1997 report on spectrum policy: "No government agency . . . can reliably predict public demand for specific services or the future direction of new technologies."[21] Moreover, note Rosston and Steinberg, markets surpass central planners in their ability to evaluate rival technologies even when those markets are less than perfectly competitive:

> In a perfectly competitive market, firms will produce the combination of goods and services most desired by consumers in the most efficient manner, and will offer these goods and services at competitive prices. In this way, the market achieves technological and allocative efficiency. Furthermore, entrepreneurs have an incentive to enter, where feasible, into production of goods and services that have been provided on a less than fully competitive basis, since these products tend to offer the greatest opportunities for profits. Thus, if reasonably competitive conditions exist and significant market failures do not occur, the market achieves economically efficient use of resources more quickly

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20. Atai & Gordon, *supra* note 7, at 3–4.

21. GREGORY L. ROSSTON & JEFFREY S. STEINBERG, USING MARKET-BASED SPECTRUM POLICY TO PROMOTE THE PUBLIC INTEREST 4 (FCC Jan. 1997).

and more reliably than government regulation.[22]

Unfortunately, the *Notice of Inquiry* in this proceeding lacks that clarity of analysis. Instead, the Commission's focus on particular technological fixes to expand capacity, such as routing data traffic around LEC switches and installing ADSL access lines,[23] ignores that such capacity will fill up as long as the demand to gain access to the Internet over the PSTN is not rationed by price. The Commission should recognize, as do Rosston and Steinberg with respect to spectrum policy, that technological solutions to the congestion of the PSTN must be chosen through the interaction of customers and suppliers, not through administrative decisions that select technological winners without regard to the operation of markets.

B. Different Characteristics of the Two Types of Demands

30. Voice demand and data demand for transmission services have significantly different characteristics because they represent demand for different services. Those characteristics are important because they affect the price responsiveness and quantity of services demanded at each price.

31. Therefore, when the two services are priced in the same manner, the characteristics of the two types of demand will vary significantly, so that the cost of providing service will differ substantially as well. In a competitive market, when there are clearly identifiable differences in demand for such different services, firms will price the services differently. Such price differences are efficient because they match consumers' willingness to pay to the costs of service.

32. There are several main differences between the demand for voice transmission and the demand for data transmission:

- Pattern of demand over time
- Level of demand at a given price and price responsiveness of demand
- Rate of growth (shifts of the demand curve over time)

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22. *Id.* at 5 (footnote omitted).
23. *Notice* ¶ 313.

Those demand differences have profound implications for access pricing. We will discuss each of them in turn.

1. The Pattern of Demand Over Time

33. The time patterns of usage over the PSTN for voice demand and for data demand are considerably different. Among the ways in which those patterns differ are average call duration, distribution of call holding times, and the arrival rate of calls.[24]

34. Consider first the average call holding time. According to studies, the average call holding time for voice calls is three minutes, whereas Internet calls average twenty minutes in duration.[25] Thus, calls involving Internet access can last a very long time as computer users surf the Internet, talk on chat rooms, or check online news services. Indeed, Internet users may leave their unmetered local telephone connections on for many hours at a time, or even around the clock.

35. That phenomenon of longer holding times for Internet calls manifested itself *before* the widespread usage of flat rate pricing, with unmetered Internet access, such as that introduced by America Online in December 1996.[26] It is apparent that *after* the introduction of flat-rate, "all you can eat" pricing of Internet access, the average holding time for Internet calls is increasing still further. For example, *Fortune* reported in January 1997 that "[u]sers of popular 'broadcast'-style data services like Pointcast often leave their computers connected 24 hours a day—for the price of a single local call."[27] As a result, typical Internet sessions can last "ten times as long as the average phone call."[28] As data demand grows and voice demand retains its traditional characteristics, that relationship can only worsen unless regulators permit LECs to change fundamentally the pricing of access to the Internet over the PSTN.

24. Atai & Gordon, *supra* note 7, at 1–2.
25. *Id.* at 2.
26. *America Online Revises Price-Change Plan*, N.Y. TIMES, Nov. 25, 1996, at D9.
27. J. William Gurley & Michael H. Martin, *The Price Isn't Right on the Internet*, FORTUNE, Jan. 13, 1997, at 152.
28. *Id.*

36. The shape of the distribution of call holding times also differs for voice and data. Whereas the statistical call holding time distribution for voice calls can be represented by an exponential distribution, the distribution for data calls does not appear to be exponential.[29] That difference is due not only to the greater average duration of calls, but also to the duration of calls in the upper "tail" of the distribution, where calls of extended duration (twelve to twenty-four hours) are likely for consumers engaged in data transmission.

37. Finally, the arrival rate of voice calls can be represented as a Poisson arrival process, with residential and business subscriber lines generating an average load of about five to ten minutes per hour (that is, a load per hour of three to six centum call seconds (ccs), where a ccs is one hundred seconds).[30] In a Poisson arrival process, the number of telephone calls received in a given period at a given switch are independently distributed according to the Poisson probability distribution.[31] The systematically greater duration of Internet calls, however, qualitatively changes the statistical representation of the arrival process for calls over the PSTN.

38. Empirical studies reinforce those three general observations about the difference between voice calls and data calls. A 1996 study by NYNEX showed that holding times for data traffic were twenty to forty minutes, as compared to five to ten minutes for voice traffic.[32] Those results were based on observations occurring before the change from usage-sensitive pricing to flat-rate pricing offered by the major ISPs.

39. A 1996 study by U S WEST covering Colorado, South Dakota, Utah, and Washington examined ISPs, value-added networks (VANs), on-line providers (OLPs), and bulletin board services

29. Atai & Gordon, *supra* note 7, at 2.

30. *Id.*; *see also* 3 BELL COMMUNICATIONS RESEARCH, TELECOMMUNICATIONS TRANSMISSION ENGINEERING 131–46 (Bellcore 3d ed. 1990). One hour of continuous use of a circuit would consume 3,600 seconds, or thirty-six ccs.

31. MORRIS H. DEGROOT, OPTIMAL STATISTICAL DECISIONS 35 (McGraw-Hill 1970); 1 WILLIAM FELLER, AN INTRODUCTION TO PROBABILITY THEORY 157 (John Wiley & Sons, Inc. 3d ed. 1968). For an early explication, see F. Thorndike, *Applications of Poisson's Probability Summation*, 5 BELL SYS. TECH. J. 604 (1926).

32. Letter from Kenneth Rust, Director of Federal Regulatory Affairs, NYNEX, to James D. Schlichting, FCC, and attached report, July 10, 1996.

(BBSs).[33] The report found that the average holding times per data call was three to eight times longer than the average holding time for the typical residential or business voice user.[34] The U S WEST study also established distinct differences between the peak periods for data demand and voice demand.[35]

40. A 1996 study by Bell Atlantic found that the average length of ISP calls was 17.7 minutes as compared with an average of four to five minutes for all other calls on its network.[36] Moreover, Bell Atlantic found significant differences between the peak periods of voice demand and those of data demand.[37]

41. How can the consistent differences between voice and data demand be explained? Economic reasoning suggests that the fundamental differences in the two activities provide an explanation. Voice users are limited in terms of telephone call duration because of the opportunity cost of time of the two callers. Even though they pay a flat rate, so that staying on the line is free otherwise, calls are limited in duration by the time cost of remaining on the line and the effort expended to carry on a conversation. The need to use the telephone to place another call, or the chance of missing an incoming call, may also play a role in limiting the duration of calls. Those latter concerns are indicated to some extent by the demand for call-waiting services and the demand for second lines for voice usage, respectively.

42. Some of those concerns are conspicuously absent in data calls. The computer is left connected to the telephone line, so that the caller's opportunity cost of time is not affected because the person does not have to spend time on the telephone. Nor does the person need to spend any effort to remain connected. The termination of calls by ISPs due to the passage of some period of inactivity during the on-line session creates some cost of effort for the user to remain connected, although those automatic

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33. U S WEST COMMUNICATIONS, ESP NETWORK STUDY [hereinafter U S WEST STUDY], *attached to* Letter from Glenn Brown, Executive Director of Public Policy, U S WEST, to James D. Schlichting, FCC, Oct. 1, 1996.

34. *Id.* at 1.

35. *Id.* at 1-2.

36. BELL ATLANTIC, REPORT ON INTERNET TRAFFIC (Mar. 1996) [hereinafter BELL ATLANTIC REPORT], *appended to* Letter from Joseph J. Mulieri, Director of FCC Relations, Bell Atlantic, to James D. Schlichting, FCC, June 28, 1996.

37. *Id.* at 3.

cutoffs can be thwarted by software that gives the illusion that the connection is in use and thus obviates any human effort by the user to remain on line. Admittedly, the need to place other calls and the concern over missed calls also apply to data traffic. Those concerns, however, explain the great increase in demand for second lines that are then used for data calls. Once data traffic is moved onto a second line, the duration of data calls is no longer limited by the need to make or receive voice calls because they can be made on the user's primary line.

43. When demand varies over time for a service provided with scarce capacity, the standard economic recommendation is peak-load pricing.[38] Pricing based on time of use sets high prices during the peak periods and lower prices during off-peak periods. Such pricing shifts some of the load from the peak periods to off-peak periods as consumers change their time pattern of usage in response to price incentives. The differences in the pattern of demand over time between voice calls and data calls suggest that the pricing solution is not peak-load pricing. Although it may make sense for there to be peak-load pricing of some types of voice traffic to smooth the peaks and troughs—and similarly there may be a need for peak-load pricing of some types of data traffic—such pricing alone is not sufficient to address the problem of combined traffic, with the possibility of data traffic creating congestion for voice traffic. Peak-load pricing of generic transmission over the circuit-switched network does not answer the need to transmit those two types of traffic separately.

2. The Level of Demand at a Given Price and the Price Responsiveness of Demand

44. Many data-related calls take place over the local exchange because dial-up access of ISPs generally is billed to the end user as a local call. Because there is flat-rate pricing of local service, the marginal cost of calls is zero to the user, whether the consumer is making a data call or a voice call. Thus, because the price of the two calls is zero, it is possible to compare the demands for the two calls at the same price. Because the characteristics of the two types of demand differ substantially, as noted

38. *See, e.g.*, ROGER SHERMAN, THE REGULATION OF MONOPOLY 94–109 (Cambridge University Press 1989); DANIEL F. SPULBER, REGULATION AND MARKETS 174–77 (MIT Press 1989).

previously, it is possible to conclude that the level of demand at a given price will generally be substantially different, judging from a comparison of demand at the zero price.

45. Economists refer to the price responsiveness of demand as the *price elasticity* of demand, which is measured as the percentage change in quantity demanded of a good divided by the associated percentage change in the price of the good. The evidence on the duration and frequency of data calls suggests that the price elasticity of demand for voice calls and the price elasticity of demand for data calls differs considerably as well.

46. There is evidence that the price responsiveness of data calls is significant. When America Online switched from metered service to flat-rate pricing, it experienced a significant increase in demand. The increase in demand became evident by the significant congestion of its existing capacity that followed the change in its pricing policy. Previously, the company had charged a lower fee but billed by the hour when customers exceeded a monthly limit on the number of hours of use.

47. Additional study would be required to compare the elasticities of demand of data calls and of voice calls. One useful indicator of the difference between the two demands, however, is the responsiveness of data demand to changes in the price of on-line services. According to America Online, the introduction of flat-rate pricing in late 1996 raised daily usage *per member* from approximately twelve minutes to approximately thirty-one minutes, and total daily usage from one million hours to over four million hours, comparing December 1995 with January 1997.[39] Over the same period daily sessions rose from approximately three million to about ten million, and peak simultaneous usage grew from below 100,000 to over 250,000.[40]

48. A customer's minutes of use of the on-line service is equal to the customer's minutes of use of the LEC's network. Thus, the elasticity of usage of the on-line service with respect to the price of using the on-line service indicates the effects of changes in the per-minute pricing of network access.

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39. David S. Hilzenrath, *At This Rate They'll Be Swamped*, WASH. POST, Jan. 24, 1997, at D1.
40. *Id.*

There are two implications of the jump in demand experienced by the on-line services. First, data demand is highly price-sensitive, so that access charges would affect usage of on-line services. Second, with flat-rate pricing of local exchange service providing access to ISPs and flat-rate pricing of on-line and Internet access services themselves, the usage of those services indicates the current level of data demand at a zero usage price. Observed demand can be expected to increase further over time as customers discover what services are available, as more consumers purchase computers, and as the on-line services upgrade the quality of their services.

49. In competitive markets, the vast difference between the elasticities of demand for the voice segment and the data segment of the market would cause differences in pricing. Companies would have an incentive to separate those two types of demand for transmission services, with their distinct usage characteristics, and price accordingly. Differences between voice demand and data demand, accompanied by common flat-rate pricing of PSTN transmission and zero access charges, create an opportunity for ISPs to free ride on the local exchange.

3. The Rate of Growth of Demand

50. Growth of demand is defined as the increase in the amount demanded at each price. The entire schedule of quantity demanded at each price increases when demand grows. A graphical representation of demand growth is a shift of the demand curve to the right. When transmission prices are relatively stable, increases in the quantity demanded are sufficient to indicate that the demand curve itself is shifting "outward." (Such outward shifts of the demand curve are in contrast to the quantity increases that are associated with movement *along* the demand curve.) An examination of the growth of Internet traffic in 1996 strongly suggests that the demand curve is shifting outward: Market demand for data transmission is growing.

51. There are many different measures of the growth of data demand on the PSTN. One measure is the growth of ISPs themselves. The *Directory of Service Providers*, published by *Boardwatch*

Magazine, counted 1,455 ISPs in March 1996 and 3,068 ISPs by the fall of 1996, more than double the number of providers in less than a year.[41] The March/April 1997 issue of the *Directory of Service Providers* lists approximately 3,640 ISPs.[42]

52. Overall Internet usage exhibits continued growth. The number of users is doubling every year, while traffic on the Internet backbone was growing by a factor of five in 1996.[43] The Yankee Group has estimated that the number of households connected to the Internet will grow from fifteen million in 1997 to forty-three million within four years.[44] That explosive growth is currently concentrated in dial-up access over the PSTN (using POTS and ISDN) rather than in dedicated access. That concentration will continue according to Drs. Atai and Gordon of Bellcore: "while new technologies such as ADSL and cable modems will grab a segment of the Internet access market, the PSTN will carry most Internet access traffic for at least the next 5 years."[45]

53. The continued growth in demand for data transmission will be driven by improvements or price reductions for products that are complementary to data-based services: computers, software, and information services. The continuing drop in prices for computers and the development of inexpensive web appliances for connecting to the Internet over telephone lines will further stimulate data demand. Increasing competition between software providers for Internet browsing and Internet-enabled "groupware" (including Microsoft and Netscape) promises to attract more customers and further increase the demand of existing customers, as capabilities for e-mail, accessing information, and on-line discussion are enhanced.[46]

C. Matching Supply and Demand

54. Markets match customers and suppliers. In an efficient market, demand and supply

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41. *Reported in* BUS. COMM. REV., Dec. 1996, at 12.
42. Based on a telephone call to BOARDWATCH MAGAZINE (Littletown, Co.).
43. John M. McQuillan, *Rebuilding the Public Infrastructure for Data*, BUS. COMM. REV., Dec. 1996, at 14.
44. Steve Lohr, *Pushed by States, America Online Agrees to Refunds in Internet Jam*, N.Y. TIMES, Jan. 30, 1997, at A1.
45. Atai & Gordon, *supra* note 7, at 1.
46. Jon Udell, *Net Applications: Will Netscape Set the Standard?*, BYTE, Mar. 1997, at 66.

options are matched efficiently. For example, in the housing market, buyers seeking two-story houses in a particular price range are matched with sellers offering two-story houses in that price range. Thus, the phenomenon of market clearing represents more than total supply equalling total demand. The specific needs of buyers are matched with the characteristics of services offered by sellers.

55. In the same way, an efficient market for telecommunications would match the transmission needs of consumers with the transmission services of communications companies. Given current transmission systems, efficient resource allocation would mean that the market should make the following matches:

- The demand for voice transmission would be matched with the supply of circuit-switched transmission
- The demand for data transmission would be matched with the supply of packet-switched transmission

Such matching has already occurred for large businesses and large organizations that connect to regional ISPs. The same matching has not occurred for residential and small business customers using the PSTN because the voice transmission alternative is priced too low due to the flat-rate pricing of local services and zero access charges for ESPs.

56. Price regulation forces the prices for voice services and data services to remain identical. Flat-rate pricing of local service and zero access charges eliminates the incentives for consumers to distinguish between voice demand and data demand in their usage of the PSTN. Moreover, price regulation creates incentives for ISPs to rely on the PSTN to connect customers with their points of presence. As we will demonstrate, differences in the costs imposed on the PSTN by the two types of usage may create incentives for the LECs to separate the traffic and thus better match demand and supply alternatives. The Commission's zero access charge regulation, however, reduces the incentives for the LEC to invest in the required facilities.

D. Adverse Selection

57. The combined usage of the circuit-switched local system by voice demanders and data demanders is a classic case of "adverse selection." Adverse selection, a term that economists have borrowed from the insurance industry, refers to a particular type of market distortion that can arise as a consequence of information asymmetries between buyers and sellers.[47] The classic example of adverse selection in economics is the "market for lemons."[48] In insurance, if the price of the contract reflects the *average* quality of the applicants, there will be a tendency for the high-quality applicants to self-select out of the market, such that the firm will be left with the low-quality applicants. Similarly, in a market for used cars, where the sellers have better information about the quality of the cars than the buyers, if the price reflects the average quality of the cars, there will be a tendency for the owners of high-quality cars to leave the market. Thus, a "pooling" contract that attempts to price to the market average can be problematical for the firm: After self-selection occurs, the firm will not face the "average" customer, and the contract will no longer be economically viable for the firm. In competitive markets, firms counteract the problem of asymmetric information and the corresponding adverse selection by offering menus of contract options (or by specializing in serving market segments) so that buyers "self-select" the pricing and service options that best suit their needs.

58. The adverse selection problem pervades local exchange telephony. The LEC cannot distinguish between a voice demand call and a data demand call, although the callers know what type of transmission they are seeking. Thus, both types of call appear as voice calls to the LEC.

59. The combined usage of the PSTN by voice demanders and data demanders represents a particularly serious adverse selection problem. The pricing and operation of the PSTN represents pricing based on the average *voice* user, whose demand patterns fundamentally differ from those of the average

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47. *E.g.*, JOSEPH E. STIGLITZ, ECONOMICS 154–57 (W.W. Norton & Co. 1993).

48. George A. Akerlof, *The Market for "Lemons": Qualitative Uncertainty and the Market Mechanism*, 84 Q.J. ECON. 488 (1970).

data user. The fact that many people are both voice users and data users does not affect the comparison. Thus, contracts intended for voice users are being offered and accepted by data users. Inevitably, the offering that was economically viable for one group is not so for the pooled group. The situation is more serious than the standard adverse selection problem because the initial contract for voice users was based on averages for a single group, not the population of both types of users; the outcome will therefore fundamentally differ from the outcome without the data user group.

60. The contract for local service, with flat rates for usage and no access charges for connection to ISPs, does not effectively ration either voice usage or data usage. Rather, it encourages practically unlimited data usage of local exchange network. In time, such data usage has the potential to displace voice traffic. The ultimate effect of adverse selection is that some voice users are discouraged from use of the system. Another facet of adverse selection is that, as data usage degrades the quality of service by affecting call completion rates, both voice users and data users with a high willingness to pay for telecommunications services will be driven from the system.

61. The solution is *not* to redesign the contract so that it satisfies the requirements of an *average of voice and data user*. That prescription would place the access problem squarely into the adverse selection framework. The resulting contract could drive one group or the other, or some members of each group, from the market, so that the contract would again be flawed because its design would be predicated on an average of users. Rather, as in competitive markets, the efficient result is to design contracts and services that allow data users and voice users to select those contracts and services that are individually tailored to their respective requirements.

62. In short, the adverse selection problem implies that the solution is not simply one of metering usage and charging prices based on usage, although that would certainly be an improvement over the current situation. Instead, the solution entails the identification and separation of the two classes of demand to the greatest extent possible through contracts and usage restrictions.